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**Integration of good practices and new methods for professional training
in the field of herbs processing for food and food supplements
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CHAPTER 14 NATURAL ANTIOXIDANTS AND ANTIMICROBIALS

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14.1 INTRODUCTION

- Undesirable changes in processed food are minimized with the use of additives (antioxidants).
- Antioxidant additives and preservatives have suffered some controversy regarding evidence of potential adverse health effects.
- Consumer's pressure: the trend is to use natural additives.

14.2 CHARACTERISTICS AND FUNCTIONS

NATURAL ANTIOXIDANTS

- Antioxidants: molecules that are capable of retarding oxidation reactions, produced by free radicals that contribute to cellular destruction.
- It is for this reason that a rich in antioxidants diet, such as polyphenols or thiols, prevents oxidative stress associated with cardiovascular and neurodegenerative diseases.
- These substances are essential elements to extend the shelf life of food products, as well as to increase their healthy properties.



A vertical strip on the left side of the slide shows a variety of fresh green herbs, including basil, parsley, and dill, arranged on a wooden surface.

Antioxidants could be defined as those natural or synthetic substances that added to food prolong its freshness, maintaining its characteristic appearance, taste and smell, in normal conditions, for a long period of time, through oxidation inhibition mechanisms of some susceptible components contained in food products such as oils, fats, and essential oils

Authorized antioxidants for use in food

There are two large groups of antioxidants permitted for food use:

A) Antioxidants officially recognized as such:

- **I) Natural antioxidants**

L-Ascorbic acid (vitamin C) and ascorbate
Alpha-tocopherol (vitamin E) and tocopherols
Rosemary extract

- **II) Synthetic antioxidants**

B) Alternative Antioxidants, not officially recognized as such:

I) Antioxidant Synergists

II) Bio antioxidants



- Bio antioxidants consist of a series of extracts from plants, fruits, and vegetables and derivatives, rich in natural antioxidants.
- Bio antioxidants could be defined as those natural preparations that based on its chemical composition and the presence of bioactive substances, show protection activity against oxidation of foods, both of vegetable and animal origin.



NATURAL ANTIMICROBIALS

- The use of chemical agents with antimicrobial activity (conservative) either by inhibiting or reducing microbial growth or by inactivating undesirable microorganisms is one of the oldest and most traditional ways for preserving food.
- Consumers exigency of natural antimicrobials: To find alternatives for food preservation covering the same antimicrobial properties and compatibility with food than the traditional synthetic antimicrobials.



Table 1. Current and emerging technologies for food preservation.

Partial or total growth inhibition of microbial	inactivation of microorganisms
Low temperatures (refrigeration and freezing)	Low temperatures (refrigeration and freezing)
Water activity (aw) reduced (drying, curing)	Ionizing radiation
Acidification	Adding enzymes (lysozyme)
Fermentation	Application of high hydrostatic pressures
Adding crop products (organic acids, bacteriocins)	Electric shock from high voltage (electroporation)
Vacuum and modified atmosphere packaging	Ultrasound heat and pressure
Addition of preservatives	(manotermosonicación)
Water in oil emulsions	

Source: Gould et al, 1995

- Many foods contain natural compounds with antimicrobial activity.
- The use of food additives of natural origin involves the isolation, purification, stabilization and incorporation of these compounds to food with antimicrobial purposes, without adversely affecting the sensory characteristics, nutritional and guarantee their healthiness.



The natural antimicrobial systems can be classified (Beuchat, 2001) :

- a) Animal origin. Includes proteins, enzymes such as lysozyme, lipases and proteases and polysaccharides such as chitosan.
- b) Plant origin. Includes phenolic compounds from bark, stems, leaves, flowers; organic acids present in fruits and phytoalexins produced in plants.
- c) Microbial group. Includes compounds produced by microorganisms.



Table 2. Compounds with antimicrobial activity found in plants, herbs and spices

Plant, herb or spice	Main composite	Other compounds
Garlic (<i>Allium sativum</i>)	Diatil disulfuro, diali trisulfuro	Dietil sulfuro, alicina
Basil (<i>Ocimum basilicum</i>)	d-linalol, metil cavicol	Eugenol, cineol, geraniol
Cinnamon (<i>Cinnamomum zeylanicum</i>)	Cinnamic aldehyde	l-linalol, <i>p</i> -cimeno, eugenol
Onion (<i>Allium cepa</i>)	d-n-propil disulfuro	
Coriander (<i>Coriandrum sativum</i>)	d-linalol	d- α -pineno, β -pineno
Clove (<i>Syzygium aromaticum</i>)	Eugenol	Cariofileno
Cumin (<i>Cuminum cyminum</i>)	Cuminalhehido	<i>p</i> -cimeno
Tarragon (<i>Artemisa dracunculus</i>)	Metil cavicol	Anetol
Lemongrass (<i>Cymbopogon citratus</i>)	Citral	Geraniol
Marjoram (<i>Origanum marjorana</i>)	Linalo, cineol, eugenol	Metil cavicol
Mustard (<i>Brassica hirta</i>)	Alil isotiocianato	
Oregano (<i>Origanum vulgare</i>)	Timol, cravacrol	α -pineno, <i>p</i> -cimeno
Parsley (<i>Petroselinum crispum</i>)	α -pineno, fenol-eter-apiol	
Black pepper (<i>Piper nigrum</i>)	Monoterpenes, sesquiterpenes	Oxigenates
Rosemary (<i>Rosmarinus officinalis</i>)	Borneol, cienol	Canfor, α -pineno
Thyme (<i>Thymus vulgaris</i>)	Thymol	Carvacrol, l-linalol, geraniol
Vanilla (<i>Vanilla planifolia</i>)	Vanill in	<i>p</i> -hidroxi benzóicos acids

Source: López-Malo et als, 2000



Phenolic compounds have been used as antimicrobial agents since 1867. They can be classified into the following groups:

- **Simple phenols and phenolic acids:** p-cresol, 3-ethylphenol, vanillic acid, ellagic acid, gallic acid, hydroquinone.
- **Hydroxycinnamic acid derivatives:** p-coumaric acid, ferulic, caffeic and sinapic.
- **Flavonoids:** catechins, proanthocyanidins, anthocyanins and flavones, flavonols and their glycosides.
- **Tannins:** polymeric phenols from plants with the ability to precipitate proteins from aqueous solutions.

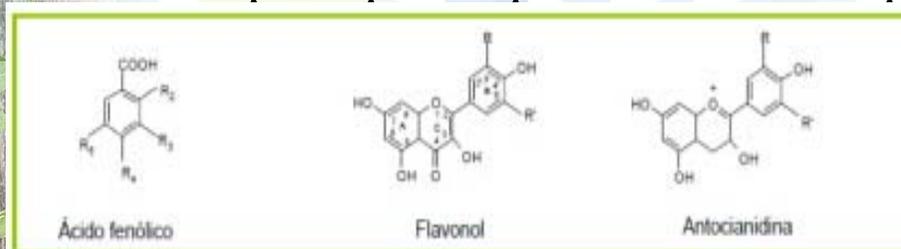


Figure 1. Phenolic derivatives in plants

14.3 APPLICATIONS IN FOOD AND EFFECTS

Blueberry extract

- Scientific studies conducted in universities, have shown that blueberry extract possesses healthy and technological effects.
- Its botanical name is *Vaccinium myrtillus* and *Vaccinium corymbosum*, the family of the Ericaceae. It is a fruit from Asia and North America.
- It has many health benefits (prevention of cardiovascular disease, regulating the digestive process and dermatological protection, among others), and technological effects as a preservative with bacteriostatic properties and it is particularly suitable for conservation from raw meats.
- Blueberries are rich in bioactive substances called anthocyanins, which are polyphenols with a high bacteriostatic activity.



A vertical strip on the left side of the slide shows a variety of fresh green herbs, including basil, parsley, and dill, arranged on a dark wooden surface.

Extract / juice pomegranate

- Its botanical name is *Punicum granatum* (meaning apple with seeds), and comes from North Africa, West Asia, Egypt, Saudi Arabia, Southern California and Spain.
- It has excellent health properties (high cardiovascular - the highest known- protection, reducing cholesterol and antihepatotoxic, among many other benefits), as well as giving virucidal effects and it is a powerful antioxidant.
- The extract/juice of pomegranate is rich in tannins, being punicalagin the most important bioactive substance.

The title 'Amaranth extract' is written in a bold, black, sans-serif font. It is positioned to the right of a vertical strip of various fresh green herbs, including basil, parsley, and dill, which are arranged on a wooden surface.

Amaranth extract

- It comes from South American countries
- It has beneficial effects as free-of-gluten energy source with a high content of albumin, essential fatty acids and amino acid containing more lysine concentration of minerals and iron and phosphorus than other cereals such as rice, wheat, barley, etc.
- Moreover, it acts as a potent fungicidal preservative to baked goods, substituting propionic acid and propionates, with the advantage of improving the taste of bread and its stability versus fermentation.

A vertical strip on the left side of the slide shows a variety of fresh green herbs, including basil, parsley, and dill, arranged on a dark wooden surface.

Olive oil

- Olive oil, extracted by natural means from olives, has both health benefits to the human body, because its high level of monounsaturated fatty acid (omega-9: oleic acid) and other polyunsaturated fatty acids, and important technological effects.
- Olive oil is rich in a bioactive substance, hydroxytyrosol (polyphenol), which has a high antioxidant power, together with other substances: caffeic acid and oleuropein.

A vertical strip on the left side of the slide shows a variety of fresh green herbs, including basil, parsley, and dill, arranged on a light-colored wooden surface.

Marjoram oil

- It has health benefits (cardiovascular protection, reduction of cholesterol, hypolipidemic, among others) but could also be used by its technological properties as a good bacteriostatic against pathogens in meat beef, pork, etc., especially against *Escherichia coli* 0157 and *Salmonella*. The bioactive substance is carvacrol.

Garlic

- The botanical name is *Allium sativa*. Its health benefits are widely known but due to the lasting smell and that it also produces artery hypertension it cannot be consumed in high quantities. Its technological effects are as a bacteriostatic preservative of wide spectrum due to bioactive substances: alliin, and various sulfurous substances (sulfide, disulfide, trisulfide and allyl tetrasulfide).

A vertical strip on the left side of the slide shows a variety of fresh green herbs, including basil, parsley, and rosemary, arranged on a dark wooden surface.

Rosemary extracts (E392)

- It has been one of the latest to be declared as an antioxidant additive. It is rich in antioxidants bioactive substances such as rosmarinic acid and carnosine, which help prevent the oxidation of a large amount of food of animal and vegetable origin containing oxidation-labile substances.

Spices and herbs.

- Certain spices inhibit the growth of microorganisms. They and their essential oils are generally more effective against gram-positive organisms than against gram-negative bacteria:

Cinnamon, cloves and mustard: great preservative power.

Black / red pepper, ginger: weak inhibitors against a variety of microorganisms.

Pepper, bay leaf, coriander, cumin, oregano, rosemary, sage and thyme: intermediate activity.

14.4 ADVANTAGES AND DISADVANTAGES



Some of the advantages of using natural extracts are:

- Consumers do not associate them with artificial additives.
- Extracts have less regulation than pure chemicals.
- Some present synergies between them, the most effective extract the pure compound.

Some of the disadvantages of using natural extracts are:

- a high concentration is required to obtain an effect of preserving and therefore changes in the taste may occur.
- For the application of natural antimicrobial and natural antioxidants, it is needed to check their effectiveness "in vitro" in microbiological media and also in food products.



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The future of naturally occurring antimicrobial and antioxidant agents is determined by the current consumer attitude to the chemical preservatives. Natural antimicrobials and antioxidants are considered as potentially reliable sources, but their actual use in foodstuffs has been established for a few cases.



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감사합니다 Natick
Grazie Danke Ευχαριστίες Dalu
Thank You Köszönöm
Спасибо Dank Tack
谢谢 Merci Seé
ありがとう

Obrigado